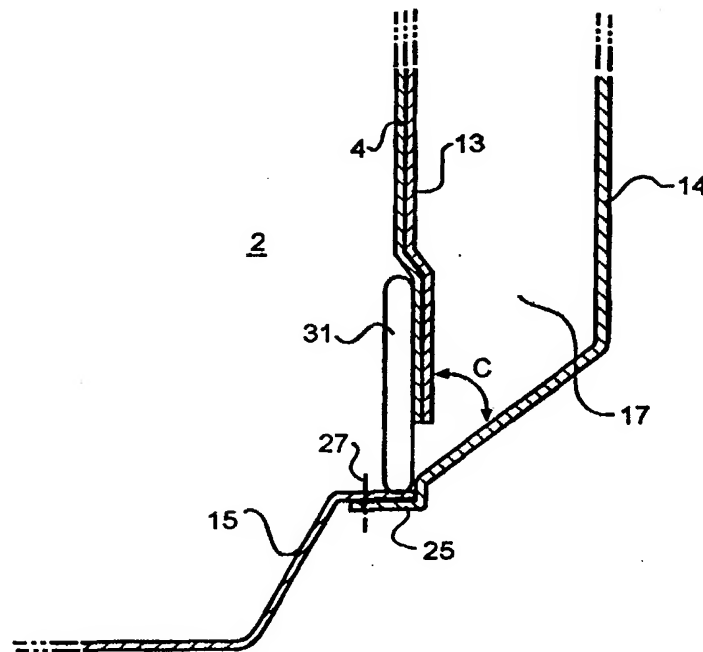




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/EP98/00711 <b>(22) International Filing Date:</b> 9 February 1998 (09.02.98)  <b>(30) Priority Data:</b> 9700530-0 13 February 1997 (13.02.97) SE  <b>(71) Applicant (for all designated States except US):</b> WHIRLPOOL CORPORATION [US/US]; 2000 M 63, Benton Harbor, MI 49022 (US).  <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only):</b> RISMAN, P.-O. [SE/SE]; Sandsjon 4480, S-438 92 Härryda (SE). CARLSSON, Dan [SE/SE]; Skepparegatan 37B, S-602 27 Norrköping (SE). NORDH, Ulf [SE/SE]; Rägängen 73, S-602 12 Norrköping (SE).  <b>(74) Agent:</b> GUERCI, Alessandro; Whirlpool Europe s.r.l., Viale G. Borghi, 27, I-21025 Comerio (IT).		<b>(81) Designated States:</b> AU, BR, CN, JP, KR, SK, TR, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>

(54) Title: MICROWAVE FEEDING OF AN OVEN CAVITY



## (57) Abstract

A device and a method for microwave feeding of an oven cavity by means of a coupling slot (1) which is fed by a waveguide. The a-dimension of the waveguide is significantly larger than the effective a-dimension of the slot. The slot comprises a radiating main slot part (5) and slot extensions (6, 7) projecting from it at its respective sides, which extensions have a substantially smaller cross-dimension than the b-dimension of the main slot part.

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MICROWAVE FEEDING OF AN OVEN CAVITYField of the Invention

The present invention relates to microwave feeding of a cavity in a microwave oven employing an elongated coupling slot made in a cavity wall, which slot is fed  
5 from a waveguide externally connected thereto.

Technical Background

The dimensioning of coupling slots for microwave feeding of the kind mentioned above often causes a number of problems. The achievement of good fixing, that is, good galvanic contact, between the feeding waveguide and the cavity wall can be problematic because of inaccess-  
10 ibility for spot welding means which at the time of manufacture have to be inserted into and behind the slot opening in connection with the spot welding of the wave-  
15 guide to the cavity. As will be appreciated, this leads to constructive limitations.

For technical microwave reasons it is often desirable that the width (so-called a-dimension) of the feeding waveguide be maintained in the whole slot area, despite the fact that the width (a-dimension) of the  
20 selected coupling slot is significantly smaller than the a-dimension of the waveguide. This can cause problems with the required spot welding in view of the plate bending desired in connection with manufacturing, as well as  
25 with concentrations of conduction current in the cavity wall plate adjacent to the slot in the area between the respective slot ends and the side wall connection associated with the waveguide. The latter is particularly pronounced in connection with simple coupling slots of  
30 the so-called H-type and when TE<sub>10</sub> mode fields are employed.

Objects of the Invention

A main object of the present invention is to make possible microwave feeding employing a relatively small

coupling slot while achieving essentially the type of field pattern which can be provided by a slot with a small a-dimension, despite the fact that the feeding waveguide employed has a considerably larger a-dimension than the coupling slot employed.

Another object of the present invention is substantially to obviate the problems described above.

A further object of the present invention is to make possible microwave feeding with increased flexibility with respect to the constructive design of the coupling slot in the cavity wall and the connection thereto of the feeding waveguide.

Yet another object of the present invention is to make possible microwave feeding which provides an additional degree of constructive freedom with respect to the action on the wall current distribution in the slot area and thereby the excitation of the cavity and the heating pattern for certain loads.

#### Summary of the Invention

The above-mentioned objects are achieved by a device and a method which exhibit the features stated in the appended claims.

The basis of the invention is thus that it has been found possible with simple means to affect the current distribution in the cavity wall areas on each side of the microwave radiating slot part out towards the respective side walls of the feeding waveguide. Such action can be achieved according to the invention by the slotting of said areas from the radiating slot part, whereby such current paths as would exist in the absence of slotting are cut off, which leads to a more even current distribution without current concentrations occurring in the areas in question.

It has been found that such a changed current distribution does not affect the excitation of the cavity fields unfavourably, but that the risk of overheating and major current losses in the areas in question is

significantly reduced. In addition, said action can be utilised to favourably adjust the excitation and the heating pattern of the cavity, as well as the impedance matching, with a basic configuration as the starting-point. In other words, an extra degree of freedom can be obtained.

The slotting according to the invention can be seen as the arrangement of an extension of the radiating coupling slot, that is, of its main part, and is effected in such a way that no appreciable microwave radiation into the cavity is obtained directly from the extra slot areas achieved as a result of the slotting. In other words, these additional slot areas will have the nature of secondary surfaces to the radiating main surface of the coupling slot. The slots are thus made narrow, that is, with a small height- or cross-dimension. This is possible because the flash-over risk will be minimal, since the electric field (in the slot plane) is at its lowest level in the areas in question and increases towards the radiating main part of the coupling slot, something which applies to, for example, TE<sub>10</sub> mode fields.

Behind each secondary slot surface a "pocket" is created in the feeding waveguide which, depending on the geometry, will constitute an inductive or capacitive member, as well as a capacitive stretch between the cavity wall at the secondary slot surface and the opposite waveguide wall. Seen from the waveguide, the pocket will function as if it were at least substantially closed, that is, as if the extra slotting did not exist. This makes it possible to affect both the field image of the coupling slot and the wave impedance for the propagating mode of the waveguide.

With respect to the required galvanic contact between the cavity and the waveguide it has been found that the invention provides better constructive opportunities for spot connections with a mutual spacing which

eliminates microwave leakage between the waveguide and cavity plates. In this connection, it is also important to note that when microwave fields of the TE<sub>10</sub> type are concerned, the power flux density which can arise at the secondary slot areas is relatively speaking very small, which further obviates any leakage problems.

According to a first aspect of the invention, a device for microwave feeding of a cavity in a microwave oven is provided, comprising an elongated coupling slot made in a cavity wall and a waveguide externally connected thereto, the coupling slot at the respective slot ends having a slot extension with a substantially smaller height- or cross-dimension in relation to the b-dimension of the main part of the coupling slot. In this connection, it is a preferred feature that the a-dimension of the main part of the coupling slot together with the length dimension of the slot extensions essentially correspond to the a-dimension of the connected waveguide.

Advantageously, the coupling slot has an essentially rectangular main part, from which a slot extension originates at each short end. The slot extensions can have an essentially constant cross-dimension, that is, have an essentially rectangular shape, or alternatively, in the direction away from the main part of the coupling slot, have a decreasing cross- or height-dimension.

Preferably, the slot edge of the cavity wall is rounded in the wall plane at least in an upper transition between the main part of the coupling slot and the respective slot extensions. This results in the formation of a configuration which can be compared to a "curtained" slot.

Although it has been found suitable that the respective slot extensions form an extension, projecting directly outwards, of the lower edge area of the main part of the coupling slot, the skilled person will appreciate that the slot extensions can be arranged at a different height relative to the slot, e.g. at the top (reversed

"curtain configuration") or symmetrically on the halfway point of the slot.

For a 2450 MHz microwave oven for domestic use, an effective slot cross-dimension, that is b-dimension, which typically is about 10 times greater than the cross-dimension of the slot extensions, has been found suitable.

According to a second aspect of the invention, a method is provided for feeding microwaves into the cavity of a microwave oven through an elongated coupling slot, which is fed by an external waveguide, employing a coupling slot whose effective a-dimension is significantly smaller than the a-dimension of the waveguide, which method comprises the adaptation of the coupling slot to the waveguide and the desired cavity excitation by the connection of a slot extension, whose cross-dimension is substantially smaller than the b-dimension of the main part of the coupling slot, to each end of the main part of the coupling slot. The slot extensions are preferably dimensioned so that no appreciable microwave radiation is received directly from the slot extensions into the cavity.

It is a preferred feature that the extent given to the slot extensions is such that together with the a-dimension of the main part of the coupling slot they essentially correspond to the a-dimension of the connected waveguide.

It will be appreciated that subsequent to the arrangement of the slot extensions on the basis of a basic configuration with a certain given slot main part, it is possible to further adapt the microwave feeding to the existing conditions by readjusting the dimensions of the main part, in particular its a-dimension and/or b-dimension.

The invention will be described in more detail below by way of an embodiment with reference to the accompanying drawing.

Brief Description of the Drawing

Fig. 1 is a schematic vertical partial view of a coupling slot in a cavity side wall in a microwave oven, the view being taken from inside the cavity.

5 Fig. 2 is schematic vertical partial sectional view taken along line II-II in Fig. 1.

Description of Embodiment

Figs 1 and 2 illustrate an example of the arrangement of a coupling slot according to the invention in an otherwise conventional microwave oven for domestic use. The coupling slot 1 is arranged in a stamped (seen from inside the cavity room 2), rectangular slot wall area 3 in the lower part of a cavity wall 4. The coupling slot 1 comprises a rectangular main part 5, which in its lower part is provided with rectangular slot extensions 6, 7 extending to each side. The connection between the respective slot extensions 6 and 7 and main slot part 5 is rounded at the top, as shown at 8, 9. The slot extensions 6, 7 essentially extend to the side walls of the posteriorly situated feeding waveguide, which side walls are indicated by dashed lines 10, 11. The width of the waveguide, that is its a-dimension  $a_w$ , corresponds to the width of the stamped area 3. The effective a-dimension of the coupling slot is  $a_s$ , that is, the width of the main part 5. The b-dimension of the main part is designated b in Fig. 1.

In addition to the indicated side walls 10, 11, the feeding wave guide has a front wall 13, which is galvanically connected to and follows the cavity wall 4, and a back wall 14, whose lowest part extends obliquely downwards forwards and under the coupling slot 1 while forming the straight lower edge 19 of the slot, to connect with the underside of the cavity bottom 15.

As seen in Fig. 2, a special pocket 17 is formed with a capacitive stretch C behind each slot extension 6, 7, that is, between the back wall 14 of the waveguide and the "curtain-like" part of the wall area 3 (see Fig. 1)



with the posteriorly situated front waveguide wall 13 which is located above the slot extension. As mentioned above, the configuration provided by said pocket will affect the microwave conditions.

5           The waveguide is connected to the cavity by a number of spot welds. The side walls 10 and 11 of the waveguide are connected to the front wall 13 of the waveguide (and thereby indirectly to the cavity wall 4) by vertical rows of spot welds 21, 22. At the bottom, the front wall 13 of  
10 the waveguide is connected to the wall area 3 above the upper edge of the main slot part 5 by a horizontal row of spot welds 23. Finally, the lower end part 25 of the back wall 14 of the waveguide is connected to the overlapping cavity bottom 15 by a horizontal row of spot welds (of  
15 which one is indicated at 27) which extends along the whole wall area 3, that is, along the whole width of the waveguide.

          All of the spot welds mentioned above are easy to achieve from a manufacturing point of view and have been  
20 found to provide fully adequate galvanic contact and sealing against microwave leakage. In this connection, it is of particular interest that the lack of spot welds in the "curtain parts" of the wall area 3 have not been found to cause any problems. This is particularly pro-  
25 nounced when non-spot-welded stretches are less than  $\frac{1}{4}$  free microwave length.

          It is suitable to cover the coupling slot in the usual manner with a protective plate, e.g. a micanite plate, as is indicated at 31 in Fig. 2. This plate is  
30 dimensioned so that it fits sealingly into the stamped wall area 3 while connecting to the cavity bottom 15, which provides an even cavity wall and an attractive overall impression. The protective plate 31 is suitably attached with the aid of screws which are fixed in holes  
35 33 in the wall area 3, whereby, simultaneously, an extra connection and galvanic contact between the cavity wall

4 and the posteriorly situated waveguide wall 13 are achieved.

The following dimensions are provided as an example of the dimensioning of a construction according to Figs 1 and 2 of a microwave oven intended for domestic use:

- A-dimension of the waveguide about 105 mm,
- A-dimension of the coupling slot about 80 mm,
- Length of slot extension about 13 mm,
- Height of slot extension about 2 mm.

## CLAIMS

1. A device for microwave feeding of a cavity in  
5 a microwave oven, comprising an elongated coupling slot  
made in a cavity wall and an external waveguide connected  
thereto, characterised in that the coupling  
slot at the respective slot ends has a slot extension  
10 with a substantially smaller cross-dimension in relation  
to the b-dimension of the main part of the coupling slot.

2. A device according to claim 1, characterised  
15 in that the coupling slot has an essentially  
rectangular main part, from which the slot extensions  
originate.

3. A device according to claim 1 or 2, characterised  
20 in that the slot extensions have an  
essentially rectangular shape.

4. A device according to claim 1 or 2, characterised  
25 in that the slot extensions have a decreasing  
cross-dimension in the direction away from the  
main part of the coupling slot.

5. A device according to any one of the preceding  
claims, characterised in that the slot edge  
of the cavity wall is rounded in the wall plane at least  
25 in an upper transition between the main part of the coupling  
slot and the respective slot extensions.

6. A device according to any one of the preceding  
claims, characterised in that the a-dimension  
of the main part of the coupling slot together with the  
30 length dimension of the slot extensions correspond to the  
a-dimension of the connected waveguide.

7. A device according to any one of the preceding  
claims, characterised in that the respective  
slot extensions constitute an extension, projecting  
35 directly outwards, of the lower edge area of the main  
part of the coupling slot.

8. A device according to any one of the preceding claims, characterised in that the main part of the coupling slot has a b-dimension which typically is 10 times greater than the cross-dimension of the slot extensions.

9. A method for feeding microwaves into the cavity of a microwave oven through an elongated coupling slot, which is fed by an external waveguide, employing a coupling slot whose effective a-dimension is significantly smaller than the a-dimension of the waveguide, characterised by adapting the coupling slot to the waveguide and the desired cavity excitation by connecting a slot extension whose cross-dimension is substantially smaller than the b-dimension of the main part of the coupling slot to the respective ends of a main part of the coupling slot.

10. A method according to claim 9, characterised by giving the slot extensions an extent such that together with the a-dimension of the main part of the coupling slot they essentially correspond to the a-dimension of the connected waveguide.

11. A method according to claim 9 or 10, characterised by readjusting, after the arrangement of slot extensions, the dimensions, in particular the a-dimension, of the main part of the coupling slot.

12. A method according to claim 9, 10 or 11, characterised by dimensioning the slot extensions so that no appreciable microwave radiation is received directly from the slot extensions into the cavity.

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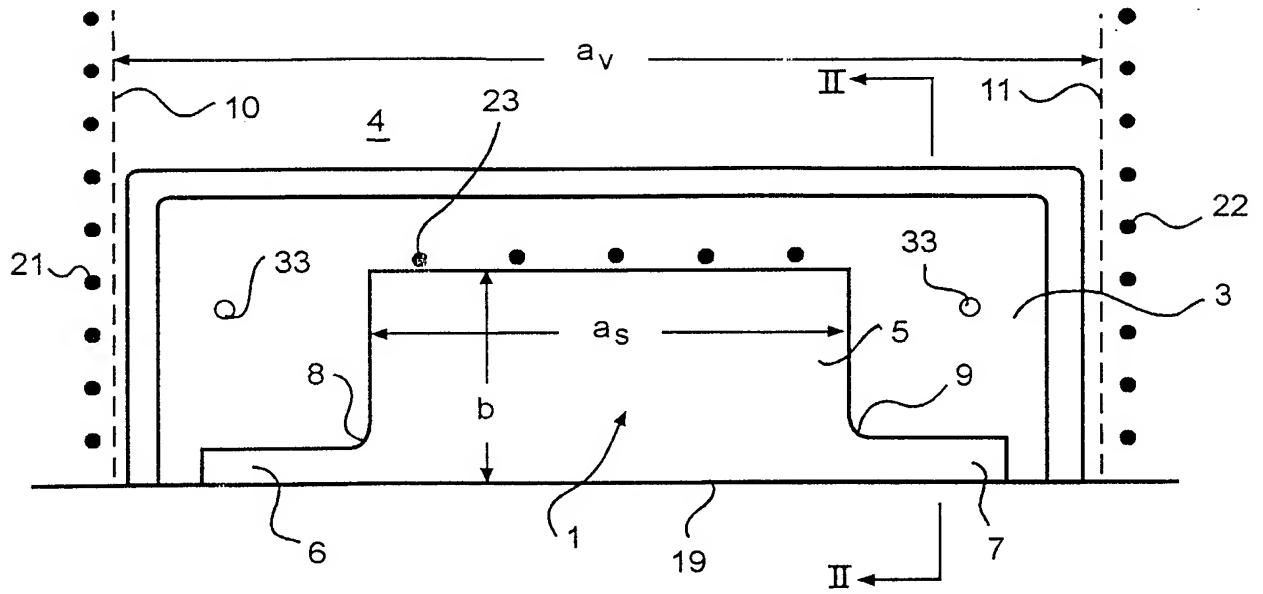


Fig. 1

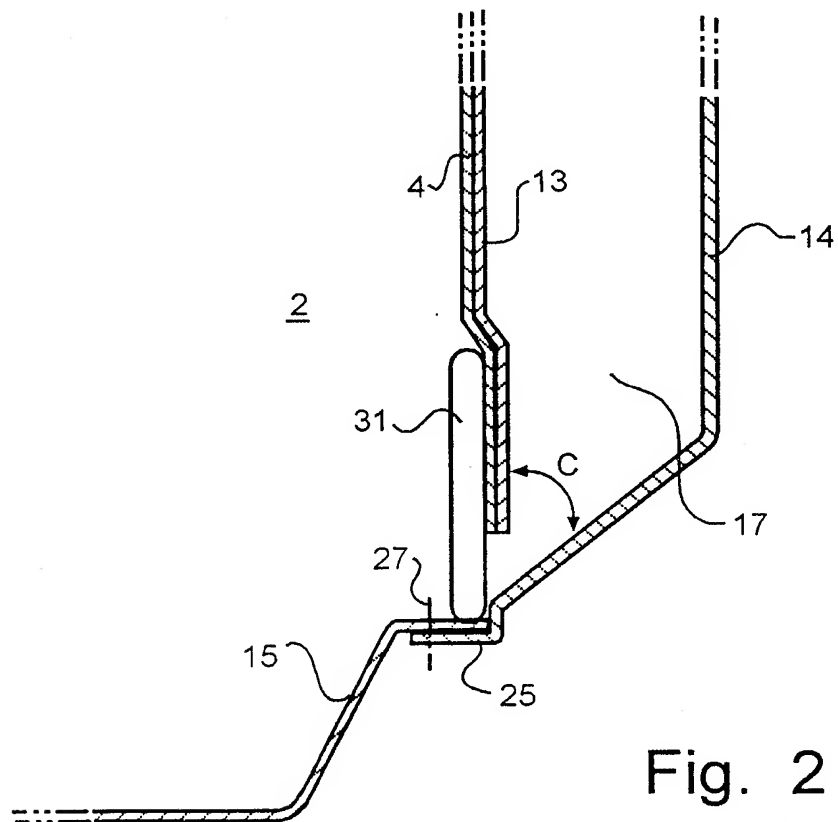


Fig. 2

# INTERNATIONAL SEARCH REPORT

In , tional Application No

PCT/EP 98/00711

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 H05B6/70

According to International Patent Classification (IPC) or to both national classification and IPC

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Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CH 684 373 A (INWAVE AG) 31 August 1994 see abstract; figure 1 ---	
A	US 4 159 406 A (BOBLLENZ ROBERT E ET AL) 26 June 1979 see abstract; figures 1,2 ---	
A	EP 0 500 036 A (MOULINEX SA) 26 August 1992 see abstract; figures 1,2 ---	
A	EP 0 430 584 A (TOKYO SHIBAURA ELECTRIC CO) 5 June 1991 see abstract; figure 1 ---	
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☒ Further documents are listed in the continuation of box C.

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European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Wansing, A

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category ?	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>PATENT ABSTRACTS OF JAPAN  vol. 008, no. 201 (M-325), 14 September  1984  &amp; JP 59 089929 A (MATSUSHITA DENKI SANGYO  KK), 24 May 1984,  see abstract; figure  -----</p>	

# INTERNATIONAL SEARCH REPORT

Information on patent family members

In. tional Application No

PCT/EP 98/00711

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
CH 684373	A	31-08-1994	NONE	
US 4159406	A	26-06-1979	NONE	
EP 0500036	A	26-08-1992	FR 2673350 A	28-08-1992
			CA 2061619 A	23-08-1992
			JP 6181092 A	28-06-1994
			KR 9603209 B	06-03-1996
			MX 9200752 A	01-10-1992
			US 5329086 A	12-07-1994
EP 0430584	A	05-06-1991	JP 2614336 B	28-05-1997
			JP 3165490 A	17-07-1991
			AU 626478 B	30-07-1992
			AU 6694490 A	08-08-1991
			CA 2030733 A,C	25-05-1991
			DE 69018782 D	24-05-1995
			DE 69018782 T	24-08-1995
			US 5111013 A	05-05-1992